P-10.6 Summarize the concepts involved in phase change.

Revised Taxonomy Level 2.4 Summarize conceptual knowledge

In Physical Science, students

- "Explain the processes of phase change in terms of temperature, heat transfer, and particle arrangement" (PS-3.7)

It is essential for students to

- Understand that the internal energy of a substance (the energy of the particles) is of two types, kinetic and potential.
  - The potential energy of the particles of a substance is due to the attractive force between the particles.
  - The kinetic energy of particles depends upon their speed
    - Temperature is a term used to describe the average speed the particles are moving, and therefore the average kinetic energy of the particles. (some move faster than others.)
    - The faster a particle is moving the more kinetic energy it has
- Explain phase change in terms of The Kinetic Theory
  - Phase change due to *increasing* the energy of the particles
    - When energy (such as heat) is added to a substance, the energy of the particles of the substance is increased, either by increasing the potential energy of the particles or by increasing the kinetic energy of the particles.
    - Both the potential energy and the kinetic energy of the particles of a substance can not increase at the same time, so both the phase and the temperature of a substance can not change at the same time.
    - Usually when energy is added to a substance, only the speed of the particles increases, they do not get further apart; so only the kinetic energy of the substance increases, not the potential energy.
      - Evidence of this would be that the temperature of the substance increases but the phase does not change
    - In order for the phase of a substance to change, energy (such as heat) must be added to a solid which is at a temperature equal to its melting point or to a liquid which is at a temperature equal to its boiling point
    - As soon as all of the particles have overcome the forces, and the phase of the substance is completely changed, then, added energy will once again be converted to kinetic energy, the phase will not change, the speed of the particles will increase, and a temperature increase will be observed.
  - Phase change due to decreasing the energy of the particles
    - Usually when energy is removed from a substance, only the speed of the particles decreases, they do not move closer together; so only the kinetic energy of the substance decreases, not the potential energy.
      - Evidence of this would be that the temperature of the substance decreases but the phase does not change

- In order for the phase of a substance to change, energy (such as heat) must be removed from a liquid which is at a temperature equal to its freezing point or a gas which is at a temperature equal to its condensation point.
- As soon as all of the particles have changed phase, removing energy will once again result in a decrease of kinetic energy, the speed of the particles will decrease, and a temperature decrease will be observed.

Assessment

The revised taxonomy verb, summarize means "to abstract a general theme or major point" For this indicator, the major focus of assessment should be to insure that students have a deep conceptual understanding of the processes involved in phase change and can describe these processes in terms of the kinetic theory. Conceptual knowledge requires that students understand the interrelationships among the basic elements within a larger structure that enable them to function together. In this case, that students understand the effect that heat being transferred into our out of a substance has on the phase and the temperature of a substance.